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TO: Gary Bailey

FROM: Paul Stasch and Marc Heffner

SUBJECT: Toxics Formed by Chlorination/Effects on Bioassays

Bioassays can be used to assess whole effluent toxicity (WET) of municipal effluents. However, bioassays do not identify the cause of any observed toxicity. This memo briefly examines the likelihood of chlorinated organic compounds being formed during effluent disinfection and what effects they may have on bioassay results. To accomplish this a limited literature review was completed and recent EILS municipal Class II Inspection data were reviewed.

CLASS II INSPECTION DATA AVAILABILITY

The volatile organic compound (VOA) and base-neutral acid extractable (BNA) data for 16 municipal Class II Inspections conducted between February 1988 and August 1991 were reviewed. Ideally, unchlorinated effluent and chlorinated effluent organics data would be available for comparison. This type of information was generally not available. Therefore, a plant influent/chlorinated effluent comparison was made for each of the municipalities (Table 1). The comparison does not distinguish between the fraction of a compound passing through the waste treatment process and the fraction that may have been formed during chlorination. BNA data are from analysis of a composite sample collected during the inspections. VOA data are generally the average from the analysis of the grab samples collected on the same day.

DISCUSSION

A total of 14 different chlorinated organic compounds were detected in one or more samples (Table 1). They were:

- Chloromethane
- Methylene chloride
- 1,2-Dichloroethene
- Chloroform
- 1,2-Dichloroethane
- 1,1,1-Trichloroethane
- Bromodichloromethane
- Trichloroethene
- Dibromochloromethane
- Tetrachloroethene
- 1,4-Dichlorobenzene
- 1,2-Dichlorobenzene
- 4-Chloroaniline
- Pentachlorophenol

Individual compounds were detected collectively 47 times in the influent and 28 times in the effluent. In only nine cases were effluent concentrations higher than in the corresponding influent. Six compounds were represented by these nine exceedances. They were:

Chloromethane
Bromodichloromethane
Dibromochloromethane
Chloroform
Methylene Chloride
Pentachlorophenol

Clear association of pentachlorophenol and methylene chloride effluent concentrations with chlorination is unlikely. Pentachlorophenol was detected once in an effluent (2 μg/L) and was not detected in any influent samples. The observance appears unusual rather than part of a pattern. Methylene chloride is used for cleaning some of the sampling equipment and is a common laboratory contaminant. Differentiating between sample concentrations and field/laboratory contamination at the methylene chloride concentrations observed is difficult for Class II sampling/analysis protocols. Although wastewater information was not found in the literature, a 1975 EPA survey of 83 cities in Region V found methylene chloride in 8% of chlorinated water supplies tested. The report concluded methylene chloride is probably not a product of water chlorination (EPA, 1975).

Chloromethane and three trihalomethanes (chloroform, bromodichloromethane, and dibromochloromethane) also were detected in the effluent at higher concentrations than in the influent. Little literature was found discussing formation of chloromethane or trihalomethanes by wastewater disinfection. A 1974 study reported the chloroform concentration increased from 9.3 μg/L in the influent to 12.1 μg/L in the chlorinated effluent at a Cincinnati, Ohio, sewage treatment plant (Bellar, *et al.*, 1974).

Trihalomethanes are commonly detected in drinking water. It is widely accepted they are produced during chlorination as the chlorine reacts with organics present in the municipal supply water. Chloroform was the most frequently detected trihalomethane in water supplies; being detected in 80 of the 80 supplies surveyed with a median concentration of 21 μg/L (Symons, *et al.*, 1975) and in 95% of 83 supplies surveyed with a median concentration of 20 μg/L (EPA, 1975). Chloroform was the most frequently detected chlorinated organic in the Class II Inspections in both influents and effluents. It's maximum average concentration in effluent detected during an inspection was 8.5 μg/L.

Comparison of the Ecology inspection data with EPA toxicity criteria is included in Table 1 to estimate potential toxic effects associated with chlorinated organics in the effluent (EPA, 1986). The criteria are much greater than chlorinated organic concentrations commonly

observed in the effluents. Thus, the chlorinated organic compounds are unlikely to cause toxicity.

SUMMARY AND CONCLUSION

The data suggest formation of chlorinated organics by chlorination of municipal effluents may occur; however, these are typically low molecular weight, volatile compounds. The effluent concentrations observed for chlorinated organic compounds were much less than EPA toxicity criteria.

The toxicity associated with any production of these compounds would be difficult to assess and likely inconsequential.

REFERENCES

Bellar, T.A., *et al.*, 1974. "The Occurrence of Organohalides in Chlorinated Drinking Water." Jour. Am Water Works Assoc., 67:634 (as referenced in EPA 1980b).

EPA, 1975. Preliminary Assessment of Suspected Cancenogens in Drinking Water. Report to Congress, Washington, D.C. (as reference in EPA 1980a).

------, 1980a. Ambient Water Quality Criteria for Halomethanes. EPA 440/5-80-051, Office of Water Regulations and Standards, Washington, D.C.

------, 1980b. Ambient Water Quality Criteria for Chloroform. EPA 440/5-80-033, Office of Water Regulations and Standards, Washington, D.C.

------, 1986. Quality Criteria for Water, 1986. EPA 440/5-86-001, Office of Water Regulations and Standards, Washington, D.C.

Symons, J.M., *et al.*, 1975. "National Organics Reconnaissance Survey for Halogenated Organics." Jour. Am. Water Works Assoc., 67:634 (as referenced in EPA, 1980b).

PS/MH:krc
Attachment

Table 1 – Organics Data From Municipal Class II Inspections

Municipality	Sample	VOA*** Chloromethane (µg/L)	Methylene Chloride (µg/L)	Chloroform (µg/L)	Bromodichlormethane (µg/L)	Dibromochloromethane (µg/L)	1,2-Dichloroethene (total) (µg/L)	1,2-Dichloroethane (µg/L)
Brewster	I		1 J	18				
Brewster	E		1 J	2 J				
Burlington	I		3.4 JB	12	0.4 M			
Burlington	E		3.3 JB	8.3				
Central Kitsap	I	1.2 M	2.8 B	6.8	1.3	0.4 J	0.9 J	0.7 M
Central Kitsap	E	3.4	2.1 B	2.9	0.5			
Duvall	I		1 J	12				
Duvall	E			1 J				
Ellensburg+	I							
Ellensburg+	E							
Ferndale+	I							
Ferndale+	E							
North Bend	I			2 J				
North Bend	E			1 J	3 J	3		
Okanogan+	I							
Okanogan+	E							
Orting	I			2 J				
Orting	U		68					
Orting	E							
Port Orchard	I	30		1 J				
Port Orchard	E			1 J				
Sequim	I			3.4 J				
Sequim	E			5.1 J	0.7 J			
Snoqualmie	I			4.5				
Snoqualmie	E		68	8.5				
Spokane	I		3.5 B	2.3				
Spokane	E		3.2 B					
Tacoma Central	I		37	9 J				
Tacoma Central	E		1 J	4.5 J				
Toppenish	I			4.8				
Toppenish	E			1.3				
Wenatchee	I		1 J	4.5 J				
Wenatchee	E		4 J	1 J				
Water Quality Criteria (EPA, 1986)								
Acute Fresh	(µg/L)	11,000 *(a)	11,000 *(a)	28,900 *	11,000 *	11,000 *	11,600 *(b)	118,000 *
Chronic Fresh	(µg/L)			1,240 *				20,000 *
Acute Marine	(µg/L)	12,000 *(a)	12,000 *(a)	12,000 *(a)	12,000 *(a)	12,000 *(a)	224,000 *(b)	113,000 *
Chronic Marine	(µg/L)	6,400 *(a)	6,400 *(a)	6,400 *(a)	6,400 *(a)	6,400 *(a)		

Table 1 – Organics Data From Municipal Class II Inspections (Cont.)

		VOA***			BNA***			
Municipality	Sample	1,1,1-Trichloroethane (µg/L)	Trichloroethene (µg/L)	Tetrachloroethene (µg/L)	1,4-Dichlorobenzene (µg/L)	1,2-Dichlorobenzene (µg/L)	4-Chloroaniline (µg/L)	Pentachlorophenol (µg/L)
Brewster	I							
Brewster	E							
Burlington	I	0 6 M			1 M			
Burlington	E							
Central Kitsa	I	1.1 M	2.7	47	3		5	
Central Kitsa	E			12				
Duvall	I	1 J						
Duvall	E							
Ellensburg	I							
Ellensburg	E							2
Ferndale	I							
Ferndale	E							
North Bend	I			6	2 J			
North Bend	E							
Okanogan	I					2 J		
Okanogan	E					0.7 J		
Orting	I							
Orting	U							
Orting	E							
Port Orchard	I							
Port Orchard	E							
Sequim	I				1 4 J			
Sequim	E							
Snoqualmie	I				3 J			
Snoqualmie	E							
Spokane	I			0.7 M				
Spokane	E							
Tacoma Cent	I			1.5 J				
Tacoma Cent	E			1.5 J				
Toppenish	I			32	4.1			
Toppenish	E				1.4			
Wenatchee	I	3.5 J		3 J	2 J			
Wenatchee	E							
Water Quality Criteria (EPA, 1986)								
Acute Fresh	(µg/L)	18,000 *(c)	45,000 *	5,280 *	1,120 *(h)	1,120 *(h)		20 **
Chronic Fres	(µg/L)		21,900 *	840 *	763 *(h)	763 *(h)		13 **
Acute Marine	(µg/L)	31,200 *	2,000 *	10,200 *	1,970 *(h)	1,970 *(h)		13
Chronic Mari	(µg/L)			450 *				7.9 *

Table 1 - Organics Data From Municipal Class II Inspections (cont.)

+ VOA samples were collected from compositors and were rejected as non-representative.

••• Concentration listed is the average when more than one sample was collected.

B The analyte was found in the analytical method blank, indicating the sample may have been contaminated

J The analyte was positively identified. The associated numerical result is an estimate.

M Indicates an estimated value of analyte found and confirmed by analyst but with low spectral match parameters.

• Insufficient data to develop criteria. Value presented is the LOEL - Lowest Observed Effects Level.

•• pH dependent criteria (7.8 pH used).

a Total Halomethanes

b Total Dichloroethenes

c Total Trichloroethanes

h Total Dichlorobenzenes